EXHIBIT 8

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DISTINGUISHING BETWEEN AMPHIBOLE ASBESTOS FIBERS AND ELONGATE CLEAVAGE FRAGMENTS OF THEIR NON-ASBESTOS ANALOGUES

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INTRODUCTION

In 1986, a letter of correspondence to the New England Journal of Medicine (Germine, 1986) communicated that 2-4% tremolite asbestos was present in a crushed carbonate marble, marketed as a sand to be used in children's sand boxes. Analysis of a specimen of this sand by the Environmental Sciences Laboratory for the US Consumer Products Safety Commission found that although tremolite was present in the amounts stated, it was not asbestos but rather common tremolite which, upon crushing, yielded generally blocky, prismatic cleavage fragments (see Langer & Nolan, 1987 and Figures 1,2,3).

The criteria used by Langer and Nolan (1987) to distinguish asbestos fibre from cleavage fragments included data which appeared in the mineralogical literature over the past decade or more. These data indicated that a mineral occurred as a monoclinic amphibole asbestos when it: possessed anomalous optical properties (*e.g.*, parallel extinction); was composed of fibrils rendering it polyfilamentous; its fibrils were curvilinear and splayed, and possessed in greater or lesser degree fibril parting along (100) twin and (010) planes; its fibrils displayed extreme length and narrow diameter, *etc.* (Figures 4,5). None of these properties nor characteristics were observed for the tremolite found in the play sand (compare Figures 1 and 4). Langer and co-workers (1987) had described tremolite asbestos in a whitewash in Greece as an agent of pleural disease there (Constantopoulos *et al.*, 1987).

In his reply to Langer and Nolan (1987) who characterized the tremolite in play sand as non-asbestos, Germine (1987) suggested that the properties used to distinguish the two habits were commercially constrained "mineralogic abstractions." He stated that the criteria used by us "were not consistent with those used in (our) past work" (ca. 1975). Since that time, more data had become available on the nature of these minerals. The data presented here form the scientific basis for the distinction between asbestos and non-asbestos tremolite.

DEFINITIONS USED IN THE ASBESTOS STANDARD - BY OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION

The first OSHA Standard for asbestos regulation in the United States was promulgated in 1972. It included a broad definition of asbestos and a specific criteria for determining which fibres in the workplace were to be assayed. At the time of the first standard, asbestos was defined mineralogically as one of several silicate minerals with the following characteristics:

- Fibre bundles are composed of "hair-like" (filiform) fibrils, each with a large length-to-width ratio;
- Fibre bundles are polyfilamentous, that is, composed of fibril strands which may be easily separated by hand;
- Fibres are chemically durable and flexible and may be woven like organic fibres;
- Fibres possess diameter-dependent tensile strength.

Fibres which exhibited these properties were said to display the asbestos habit. The OSHA asbestos standard included five amphiboles (Table 1). However, it also included morphological specifications for counting asbestos fibres in airborne dust samples, i.e., asbestos was a fibre of a length $\geq 5\ \mu m$ and aspect ratio $>3:1$. The portion of the 1972 standard regarding length and aspect ratio was based on both practical and theoretical considerations:

- The 5 μm size length limit for asbestos fibre counting in a work environment was based on several factors. Firstly, it eliminated the requirement for the microscopist to distinguish short fibre from non-fibrous particles, especially important since the fibre standard (fibre/ml) replaced the total particle standard (millions of particles/ft^3). Secondly, counting of fibres greater than 5 μm in length improved the precision of the determination by a single microscopist, and especially among different microscopists analyzing the same specimen. Additionally, the fibres used in textile mills, the principal work site from which the standard was developed, produced dust containing long fibers when carded and spun. Although short fiber, $< 5\ \mu m$ in length, was the predominant component in the air, it constituted a small component of the total dust assayed by light microscopy at 100x magnification. Lastly, the then existing theory of the etiology of asbestosis was based on the disintegration of asbestos bodies over time with the release of silicic acid. Asbestos bodies were noted to form on long fibres ($\geq 5\ \mu m$) (Beattie, 1961).
- The 3:1 aspect ratio was also established as part of a counting strategy, principally to eliminate "particulates" and fibre clumps from environmental assays. Again, this form limitation improved both the precision and accuracy of fibre counting on air filters. The use of the aspect ratio was not introduced to define asbestos.

These latter elements currently remain in the standard. With time, many interpreted these counting criteria as part of the definition of what asbestos was as a material.

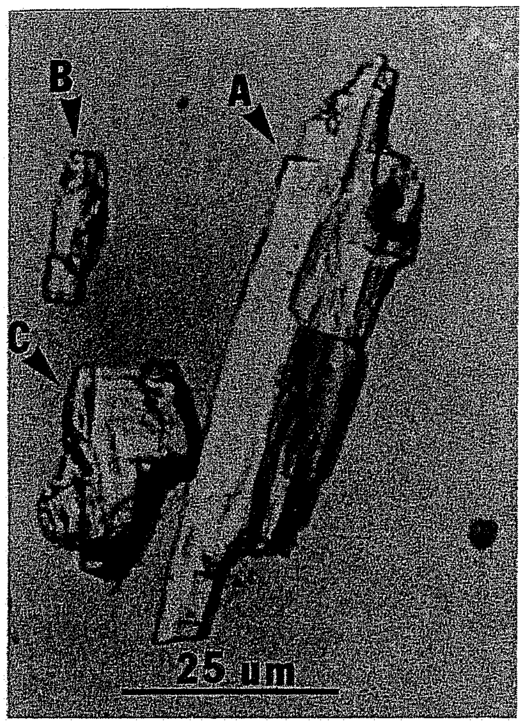

Figure 1. Cleavage fragments of tremolite recovered from a carbonate play sand from New York State. Fragments are visualized by interference light microscopy. Fragment **A** is ≈ 75 μm in length with an aspect ratio of $\approx 4.4:1$. Its surface topography displays the characteristic angular relationship anticipated for amphibole cleavage planes. Fragment **B** is ≈ 17 μm in length with an aspect ratio of $\approx 3:1$. Fragment **C** is also typical of the tremolite fragments recovered from the sand, very nearly equant in aspect ratio. None of the fragments, A, B or C, are respirable. Scale as marked. Note that all the fragments are "single crystals."

PROBLEMS EMERGING AS THE RESULT OF DEFINITIONS

The regulatory definition of asbestos used by OSHA included elements of an occupational environmental survey strategy. This mattered little in that the strategy was formulated for use in workplaces where asbestos was manipulated. However, as the workplace levels decreased and monitoring expanded to environments where asbestos and non-asbestos materials might be found, problems emerged. The definition of asbestos was too broad and many non-asbestos minerals began to be assayed as asbestos, by OSHA's definition. These minerals possessed some of the morphological characteristics similar to asbestos and had the same mineral name. Additionally, the environmental assay was to

be carried out with a phase-contrast microscope which was both resolution limited and incapable of acquiring data useful for fiber identification. Non-asbestos mineral fragments, by regulatory fiat, became asbestos.

To further complicate the issue, the hypothesis was advanced that morphology was the primary determinant of biological activity. It therefore did not matter whether the object counted by light microscopy was actually asbestos or not in that if the mineral fragment possessed a fibrous **morphology**, it should be counted as asbestos. Tremolite asbestos and tremolite cleavage fragments, if morphologically similar, became synonymous. The asbestos standard was now expanded to include elongate, non-asbestos, mineral fragments.

TABLE 1. Asbestos Minerals Cited in the 1972 OSHA Standard.

Asbestos Mineral Cited	Mineral Name	Counting Criteria; Analytical Problems
Amosite	Grunerite-Cummingtonite	Requirements for counting in workplace: >5 μm length; aspect ratio $>3:1$; <3 μm diameter; <100 μm length. *n.b.* Grunerite-Cummingtonite is **not regulated.**
Crocidolite	Riebeckite	Requirements for counting are same as for amosite. *n.b.* Riebeckite is **not regulated.**
Chrysotile	Chrysotile	Requirements for counting are same as for amosite. Is always asbestos.
Actinolite	Actinolite	Requirements for counting are same as for amosite. Same name for asbestos fibre and mineral, which may occur with **non-asbestos habit.** Possible to include cleavage fragments as "asbestos" in filter analysis, especially with phase contrast microscopy.
Anthophyllite	Anthophyllite	Requirements for counting are same as for amosite. Problems of distinguishing asbestos and non-asbestos varieties are the same as for actinolite.
Tremolite	Tremolite	Requirements for counting are same as for amosite. Problems of distinguising asbestos and non-asbestos varieties are the as for actinolite.

Figure 2. Transmission electron micrograph of a water-fractionated fine-size fraction of the carbonate play sand. Arrowhead indicates a tremolite particle within the carbonate martrix, ≈ 0.9 μm in length, ≈ 0.15 μm in width (AR $\approx$ 6:1). About 18% of the fragment population displays aspect ratios $\geq$ 5:1; about 1.5% $\geq$ 10:1. Most of the respirable tremolite fragments are less than 5 μm in length.

STATE OF THE ART IN IDENTIFICATION OF ASBESTOS; BIOLOGICAL DIFFERENCES

Since 1972 when the United States asbestos standard was set, new mineralogical and crystallographical studies of the asbestos minerals and their non-asbestos analogues have contributed to the modern understanding of their structure and properties. These studies have helped to explain the anomalous optical properties of the monoclinic amphibole asbestos minerals and their relationship with their non-asbestos analogues. These forms can be distinguished.

Data accumulated which suggested that amphibole asbestos, and its non-asbestos analogues, possessed very different biological potentials (Wagner *et al.*, 1982; Addison and Davis, 1988; Nolan *et al.*, 1991). Therefore, it is important to distinguish among them. The question arose as to the criteria and methods which could distinguish between different forms of the same mineral.

TABLE 2: Comparison of the Physical Characteristics Displayed by Tremolite Asbestos from Metsovo, Greece and Non-Asbestos Tremolite found in a New York Play Sand.

Property	Tremolite Asbestos (Metsovo White-Wash)	Tremolite Cleavage Fragments (NYS Play Sand)
By Polarized Light Microscopy		
Fibre, on Light Optical Level,	Polyfilamentous; curvilinear; exhibits splayed ends; exhibits parallel to near parallel extinction; characteristic amphibole cleavage are observed for some few associated fragments present. Large fibrils show (100) and (010) surfaces.	Optically continuous single fragment; straight-edges along length and termination; angular extinction; amphibole cleavage discernable; no polyfilamentous bundles observed. Occasionally, some striations parallel to long axis.
Aspect Ratio	Avg. = 10.9:1, ≥20:1, 18%; Log-normal distribution towards high aspect ratios (≥10:1).	Avg. = 3.7:1, ≥20:1, 0%; Log-normal distribution towards low aspect ratios (≤5:1).
By Transmission Electron Microscopy		
Fibre/Fibril on Sublight Level	Tends toward long and thin. Parallel sides to fibril. Polyfila-mentous when in fiber.	Tends toward short and wide. Irregular stepped-sides, edges and ends.
Fibril Structure	Twins (100) frequent; closely spaced, <1.0 μm.	Twins rare; spacing >>1.0 μm.
Selected Area Electron Diffraction (SAED)	Common Diffraction Nets: (001) x (010) (001) x (100) (103) x (010) Diffraction spots common. No Kikuchi lines.	Common Diffraction Nets:* (110) x $(\bar{1}\bar{1}\bar{1})$ (020) x $(\bar{1}\bar{1}\bar{1})$ (131) x $(\bar{1}\bar{1}\bar{1})$ Diffraction spots common. Kikuchi lines common.

* Note: Most of the play sand fibres were too thick to permit passage of electrons. They are optically opaque on the TEM level

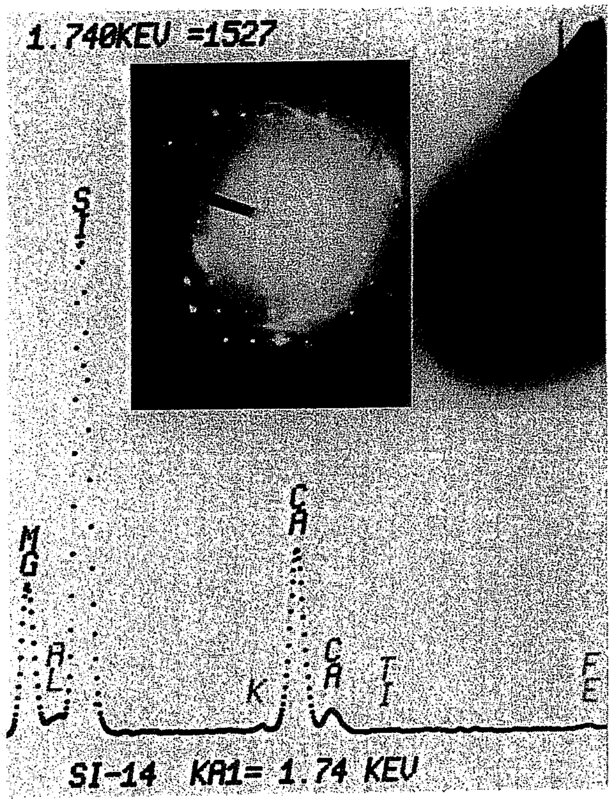

Figure 3. Transmission electron micrograph, energy dispersive X-ray spectrum (EDXS) and selected area electron diffraction (SAED) pattern obtained on tremolite fragment (upper right). The fragment's length is ≈ 6 μm, its width ≈ 3.4 μm (AR $\approx 1.8{:}1$), the SAED pattern shows Kikuchi lines indicating a thick fragment. The Laue net is about (131 x $(\bar{1}\bar{1}\bar{1})$ indicating the particle lies near the (110) cleavage plane. The EDXS indicates a chemistry consistent with tremolite.

THE NATURE OF THE AMPHIBOLE ASBESTOS MINERALS

Anomalous Properties of Asbestos

On the level of electron microscopic examination, the amphibole asbestos minerals display anomalous characteristics which were reported in the early 1970s (see, *e.g.*, Skikne *et al..*, 1971; Langer *et al..*, 1974). Fibres 0.20 μm in diameter, and greater, produce selected area electron diffraction patterns which included reflections forbidden for the space group symmetry, and spatial periodicities which were not accountable for by the amphibole unit cell dimensions. Twinning and defects were suspected as the causes of these anomalies (Langer *et al.*, 1974). It was also noted that tilting of amphibole asbestos fibers in the electron beam, at angles of up to 20°, failed to produce new symmetry nets (Skikne *et al..*, 1971; Seshan, 1976). This behavior was not observed for common amphibole minerals. It should be noted that thick fibres ($>>200$ Å in diameter) gave rise to electron effects in the crystal, *e.g.*, multiple reflections, which produced "uninterpretable" diffraction patterns. These patterns do not resemble those obtained with X-rays

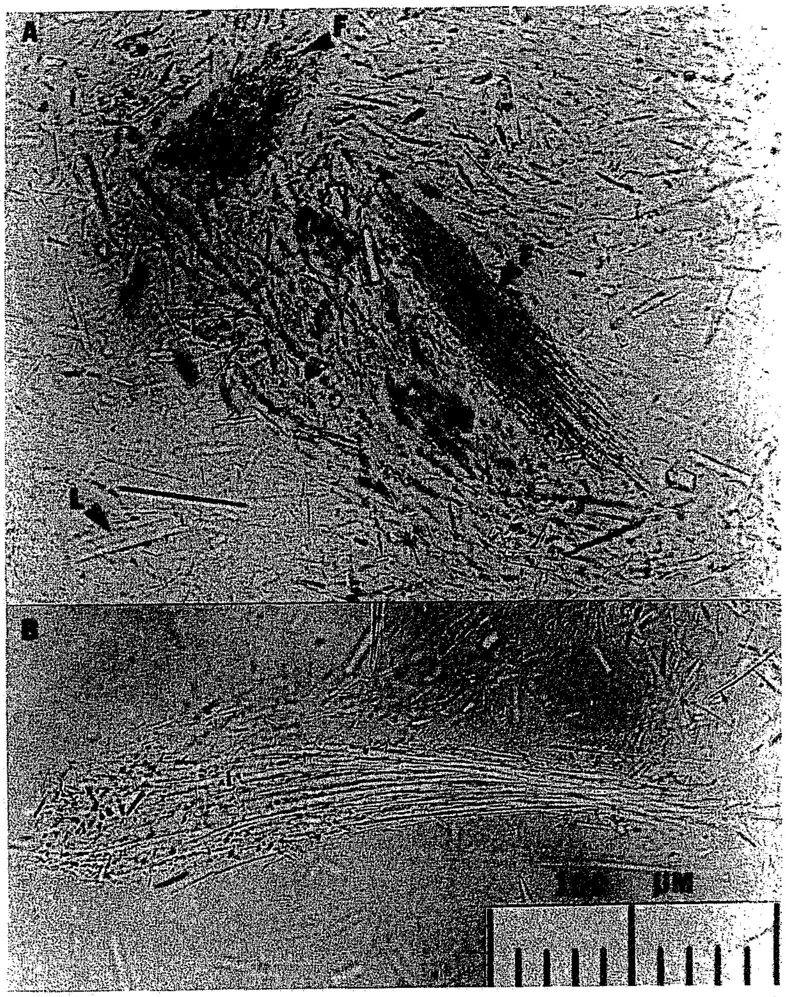

Figure 4. Tremolite asbestos, as visualized in plane polarized light. The tremolite asbestos is a major mineral component of whitewash (stucco) from Metsovo, Greece. (A) Fibrous polyfilamentous bundles of fibrils(F, arrowheads) and cleavage fragments or laths (L, arrowhead) are present. **(B)** Fibre bundle as viewed between partially crossed Nicols. The fibre bundle is clearly polyfilamentous, curvilinear and splayed open at its ends. The unit fibrils have aspect ratios exceeding 100:1. Fibre extinction is parallel. Scale as marked in (B). Compare with cleavage fragment in Figure 1.

(Whittaker, 1979). Only where very thin particles are available can diffraction data be obtained which yield interpretable patterns (Whittaker, 1979).

Nature of Twins

Twins, considered a form of crystal defect, are defined as differently oriented structural lattices (which form multiple individuals) contained within the same crystal. A number of specific symmetry operations produce these differing orientations and individuals. At the boundary of these differently oriented lattices, there exists a layer of atoms which is common to each lattice, and in which the atoms fit exactly into the structures of

each individual. When a single crystal contains these differently oriented lattices it is said to be twinned.

In monoclinic amphiboles, the twin is defined by the following symmetry operation: a mirror reflection of the same individual across a plane; the reflection plane is the (100), and it is referred to as the twin plane. It is important to add the following: the individual twins which are reflected across this plane may be faulted or offset (crystallographically referred to as translated) so that instead of the anticipated shared atom between these individual lattices, preserving crystal bond cohesive forces, the atoms in the facing twin planes occupy sites which set up repulsive forces in the crystal. This causes a reduction in cohesion. These faulted twin planes are therefore planes of structural weakness, where failure will tend to occur. Failure of this type will occur at a lower energy input than required by the cleavage process for a single, defect-free, crystal. This failure is referred to as parting rather than cleavage.

Twinning accounts, in part, for the asbestos fibre's insensitivity to tilt in the electron beam, where change in crystal orientation, unexpectedly, does not produce new patterns of reflections. These are defined by crystallographers as reciprocal lattice projections which satisfy the Laue equations for diffraction (Buerger, 1958). This behavior of amphibole asbestos fibre/fibril in the electron beam has been explained by the presence of microscopic twins. Crushed fragments of non-asbestos amphiboles very rarely display these characteristics.

Asbestos Fibril Defects

Since the mid-1970s, electron beam studies of amphibole asbestos varieties have found: a high frequency of twinning in amosite parallel to the (100) plane (Hutchison *et al.*, 1975); a high frequency of (100) twining in amosite and crocidolite (Champness *et al.*, 1976; Harlow *et al.*, 1985); the presence of "faults" along adjacent (100) twin surfaces in tremolite asbestos (Seshan & Wenk, 1976); and the presence of a high density of translated "faults" along the (100) in crocidolite (Crawford, 1980). Seshan and Wenk compared the frequency of twinning in calcic amphibole asbestos with its non-asbestos analogue. Non-asbestos tremolite, and common hornblende, exhibit the (100) twin only rarely. Harlow and co-workers (1985) compared the reflection twin (100) periodicity in amosite and grunerite. Amosite twin periodicity ranged from 0.004 μm to 0.02 μm ($\approx$40-200 Å), whereas grunerite twin periodicity was rare and ranged from 1.0 μm to 100 μm. Differences in density of planes of failure produces thin, bladed, elongate fibrils of amosite on comminution, as compared to low aspect ratio, thick fragments of grunerite. The twin plane separation, termed parting, is a lower energy process than is required for amphibole cleavage.

Comparison of Selected Area Electron Diffraction (SAED) Patterns

Harlow and co-workers (1985) also showed that amosite generated SAED patterns corresponding to particles lying on or near (100), whereas grunerite particles generally were either too thick to permit penetration of the electron beam which was accelerated at 100 kV, or produced Kikuchi lines when penetrated, or showed patterns indicating most particles lie near or at (110), the prominent amphibole cleavage plane. Dorling and Zussman (1987) have suggested that the (100) plane may be a growth surface for amphibole asbestos (see Figures 3 and 5B).

It should be noted that Kikuchi lines represent a special condition of coherent electron diffraction which produces a pattern of lines rather than discrete reflection spots.

Figure 5. Tremolite asbestos, fine fraction as visualized by TEM. (A) High aspect ratio fibres/fibrils predominate the particle population. Fragments are less common. (B) Tremolite asbestos fibrils at higher magnification display greater aspect ratios. SAED pattern (Insert B) obtained on a thin fibril, displays a $\approx$(001) x (010) net. The fibril is thin and is lying close to the (100) twin plane. Note thin fibrils ≈ 0.1 μm in width.

It is commonly observed for thick crystals before complete beam absorption (Van der Biest & Thomas, 1976 and Fig.3) in SAED.

Chain-Width Errors

In 1973, Chisholm reported the presence of anomalies in several amphibole minerals. Rather than the anticipated double-chain groups forming the *b* dimension of the unit cell ($\approx$ 18Å), the chain was formed of six planar-linked tetrahedra, producing a *b*-cell dimension of $\approx$27Å. These were termed Wadsley defects, a crystallographical

term for similar structural anomalies noted in other minerals (Chisholm, 1973; Veblen *et al.* 1977). Wadsley defects, producing compositionally anomalous (010) planes, were noted with some frequency in specimens of both amosite and crocidolite by Champness and co-workers (1976). Crawford (1980) noted the presence of single (pyroxene), double(amphibole) and triple (pyrobole) chains in UICC crocidolite. The Wadsley defects were both continuous and structurally staggered along the *a*-axis.

Random Orientation of Fibrils

Franco and co-workers (1977) added to the understanding of the structural complexity of the amphibole asbestos minerals. Transmission micrographs obtained on crocidolite showed that unit fibrils were randomly oriented with respect to their *ab* planes. Only the *c*-axes of the fibrils were in common alignment (Franco *et al.*, 1977). Using a preparation technique to reduce artifact formation, disoriented fibrils were also observed by Crawford (1980). He also observed the presence of pore spaces between some juxtaposed fibrils. This azimuthal, completely random orientation of unit fibrils which make up the asbestos fibre, was also shown to exist for actinolite asbestos, based on the polarized light microscopy studies by Wylie (1979).

Properties Produced by Structural Defects

Fibres of the monoclinic amphibole asbestos varieties, made up of fine submicroscopic fibrils, display parallel extinction when examined by polarized light microscopy. The fibres, composed of polyfilamentous bundles of fibrils, are often splayed on their ends and display curvilinear shape along the fibre axis. Indices of refraction measured on these fibres tend to show unanticipated values.

Twinning of or in large individual fibrils of monoclinic amphibole asbestos ($\geq 0.5\ \mu$m diameter) produces gross structural modification, i.e., an anomalous orthorhombic symmetry for each fibril. Three indices of refraction define each of these fibrils, but again, values are unanticipated ($n'_{\alpha 1}$, $n'_{\beta 1}$, $n'_{\gamma 1}$) and the fibre extinction is parallel rather than oblique (Wylie, 1979; Dorling and Zussman, 1987). Crocidolite fibre bundles, where unit fibrils are rotated with respect to each other and/or are small in diameter ($\leq 0.5\ \mu$m) produce fibres which display almost **uniaxial** symmetry, i.e., only **two** indices of refraction ($n'_{\alpha 1}$, $n'_{\gamma 1}$) and parallel extinction. These characteristics have been observed for fibre bundles of tremolite asbestos, actinolite asbestos and amosite.

In contrast, the monoclinic amphibole cleavage fragments display both the morphology and optical properties anticipated for the specific mineral regardless of the presence or absence of twinning. When lying on a flat surface the asbestos fibril lies principally on or near the (100) twin plane and frequently on the (010) plane. Irregular planes dominate for crocidolite (Whittaker, 1979). The fibril therefore generates diffraction patterns which are significantly different from those generated by cleavage fragments which lie at or near the (110) cleavage plane. Therefore, **populations** of fragments/fibres may be distinguished as common amphibole or as asbestos on the submicroscopic level, by a determination of their selected area electron diffraction characteristics.

Comminution of asbestos produces a dust of fine particle size, with narrow diameter fibres/fibrils, high particle number per unit mass of dust, and high surface area. These properties provide an understanding of why asbestos has a distinctly different health hazard evaluation compared to its crushed common amphibole analogue.

THE AMPHIBOLE ASBESTOS FIBRE

By the end of the 1970s, a pattern emerged which was formulated on data obtained on studies of many forms of common amphiboles and their asbestos analogues. Amphibole asbestos fibres, of all varieties, were found to consist of polyfilamentous bundles of azimuthally disoriented, fibrils. Many forms showed that each fibril was complexly twinned on (100) surfaces, and that these twins were commonly offset by faults. Some fibrils possessed chain-width errors, Wadsley defects, on (010) surfaces. These structural characteristics helped explain a number of properties unique to the monoclinic amphibole asbestos minerals which are not observed for their normal amphibole counterparts:

- For the most part, asbestos fibrils are easily separable, in part, because of translocation along the (100) twin plane, producing a much reduced cohesion. The disorientation of the fibril bundle is thought to contribute to this property. Non-asbestos analogues must be crushed to yield elongate particles;
- Mechanical manipulation of asbestos fibre produces many long, thin fibres/fibrils rapidly, as compared to identical manipulation of common amphiboles. Vigorous mechanical manipulation of non-asbestos analogues also induces failure across the fibre axis, producing short, equant fragments as compared to thin, elongate asbestos. Different physical processes are involved in the size reduction of non-asbestos amphiboles than for the disaggregation of asbestos , (in the absence of other binder minerals).
- Amphibole asbestos fibrils express planar elements (100) >> (010) > (110) > (hkl), produced by failure along the twin, defect and cleavage planes, as compared to cleavage fragments expressed planes (110) >> (010) > (100) > (hkl). The plane of cleavage dominates the expressed surfaces of crushed normal amphiboles;

The size distributions and aspect ratios for populations of asbestos fibres/fibrils show them to be mostly smaller in diameter and greater in aspect ratio than non-asbestos analogues;

- Optical properties of the monoclinic amphibole asbestos fibre are "anomalous" (indices of refraction of amphibole asbestos fibres have different values than their normal amphibole single crystals or cleavage fragments analogues);
- The monoclinic amphibole asbestos fibre bundle, made of very narrow diameter fibrils ($<0.2\ \mu m$), usually possesses a uniaxial optical indicatrix, displaying two refractive indices, rather than three; fibres display parallel extinction, rather than oblique extinction anticipated for the crystal symmetry, when viewed by polarized light microscopy (Heinrich, 1965; Wylie, 1979; Dorling & Zussman, 1987). It should be noted that tremolite asbestos was originally misidentified as anthophyllite because of the observed parallel extinction (see Heinrich, 1965);
- The different surfaces produced upon comminution, impart on amphibole asbestos fibrils a crystallographic orientation which in an electron beam differs significantly from the orientations of cleavage fragments. The different Laue zones of symmetry can be determined by SAED. This results in monoclinic amphibole asbestos fibrils, exhibiting reciprocal diffraction nets near or at, *e.g.*, (001)x(010), (001)x(100), (103)x(010), *etc.*, as compared to cleavage fragments which exhibit diffraction nets near or at (110)x(111), (020)x(111), (131)x(111), *etc.* (*e.g.*, see Lee *et al.*, 1978).

These characteristics will vary slightly as a function of mineral type and geological occurrence. In some instances, for a single isolated particle, it may be impossible to distinguish an acicular cleavage fragment from asbestos fibril.

The Current Definition

The OSHA-NIOSH definition of asbestos is a composite of mineralogical terms enmeshed in a light microscopy strategy for particle counting in the workplace. It does not uniquely identify or define asbestos. The play sand analysis is an illustration of how this broad definition led to the misidentification of cleavage fragments as asbestos. The play sand consists of cleavage fragments rather than asbestos fibre. The analytical results are summarized in Table 2. Phase contrast optical microscopy techniques and the current definition are insufficient to distinguish elongate prismatic or acicular cleavage fragments from asbestos, or many other fibrous particles.

DISCUSSION AND CONCLUSIONS

Monoclinic amphibole asbestos fibre from non-asbestos cleavage fragment can be distinguished by polarized light microscopy and by transmission electron microscopy. Study of the predominant diffraction nets by TEM requires a **population** of particles and a determination of the principal Laue zones of symmetry displayed by the diffracted objects. The asbestos fibril tends to part along planes uncommon for its non-asbestos counterpart. Its resulting diffraction nets therefore generally differ. Sub-microscopic respirable particles may thus be distinguished on a population basis. These data are too recent to be reflected in the scientific basis upon which the first regulatory asbestos standard was promulgated. A review of the OSHA asbestos standard in the United States to evaluate the merit of including some of the more recent data should be considered.

The OSHA asbestos standard is used to regulate **asbestos minerals**. In the mining and milling environment, crushing of rocks generate fragments of normal amphiboles which conform to the OSHA-NIOSH definition of asbestos. If the asbestos standard is to regulate asbestos only, then polarized light microscopy is required to identify and distinguish between the minerals present. The identification is required for effective monitoring.

The New York State play sand, which reportedly contained tremolite asbestos, did not. Rather it contained tremolite cleavage fragments. Due to no asbestos being present, there can be no asbestos risk associated with its use. The amount of respirable tremolite dust in the specimens studied, of length and diameter considered biologically important, exists in the hundreds of ppm range. Based on known properties thought to contribute to the biological potential of **mineral fibre**, the risk associated with the use of the sand is considered to be so quantitatively different from asbestos that any comparison is not justified.

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